AUTOMATION IN MUSEUM COLLECTIONS[1]

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Introduction

For a little over a year now several of us in the Smithsonian have been associated with a project designed to investigate possible uses of electronic data processing (EDP) for computer storage and retrieval of specimen-associated data. The project has been funded under a contract with the Office of Education of the Department of Health, Education, and Welfare. It is a joint effort by members of the staff of the Museum of Natural History and Information Systems Center, Smithsonian Institution.

The project is based on the thesis that a museum collection is more than an assemblage of inanimate objects or dead organisms; it is a vast information resource which we cannot adequately use with current methods of record keeping. A second factor, which is also quite important, is that collections are continually growing at a rapid rate. In the Department of Invertebrate Zoology alone, the collections are increasing by at least 200,000 specimens per year. This trend is hardly likely to change in the near future, and if specimen-associated data in the collections is too difficult to obtain now, it will be even less available in the future. If computerized data record-keeping systems are going to be developed and used, the project must be started now. Delays will only increase the difficulties and the cost.

The MNH project was designed to set up record-keeping systems in three separate areas of the museum: marine rocks, un-

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der the supervision of William Melson, Department of Mineral Sciences; oceanic birds, under the supervision of George Watson, Department of Vertebrate Zoology; and marine crustaceans, particularly stomatopods, under the author's supervision. Donald F. Squires, then Deputy Director of the Museum, was among the first to recognize the need for data processing in the museum and it was he who sought and obtained support to initiate the pilot project.

In Crustacea, the project is designed to aid management of the collection, to aid curation, and to enhance the collection as a research tool. Our primary aim was to update some of our techniques of collection management, and to develop techniques which would allow us to manipulate specimen-associated data without having to return to the collection every time we work with the data.

The overall MNH project has been divided into two phases: (1) to build a data bank based primarily, but not exclusively, on three separate collections, and (2) to manipulate the data in various ways to evaluate the overall costs of not only various portions of the project but also the costs of general handling and processing of museum collections, regardless of the ultimate use and method of storage and retrieval of the data.

The first 18 months of the contract, ending in December, 1968, have been concerned with entering the data, building up the base, and solving the innumerable problems that arose at every step. The next phase will deal principally with interrogation of the data base.

My remarks are designed to give a progress report on activities in Crustacea, an idea of some of the different problems which we have encountered and some of the results of the project.

We are not alone in the scientific community in our interest in developing a system for storage and retrieval of specimen data. The British Museum (Natural History) and the National Museum of Canada are both working on developing such a system, and system development is being considered by over 30 museums around the world. More than 70 representatives of universities, museums, zoological parks, and botanical gardens met in Mexico City, in 1967 to discuss "Information Problems in the Natural Sciences." Bullis and Roe (1967), reporting on a bionumeric code used by the Bureau of Commercial Fisheries Exploratory Fishing Base, Pascagoula, Mississippi, noted that faunal data resulting from their exploratory fishing operations necessitated development of computer methodology for handling the data.

Those of us associated with the MNH project are not the only ones in the museum working with different applications of data processing. In the Department of Botany, Stanwyn Shetler is applying EDP to the broad Flora of North America Project, and Mason Hale is developing a type-catalog, and a list of general accession records and invoice data in Botany have been computerized for some time. James Peters, Department of Vertebrate Zoology, has pioneered within the museum in developing computer programs to carry out time-consuming statistical analyses commonly used in taxonomic studies.

In a recent article on curation of invertebrate collections, Emerson and Ross (1965, p. 337) noted that: "The ideal method for cataloguing specimens and the retrieval of catalogue and specimen information would be a punch card or magnetic tape system. Vast amounts of information could be stored in a relatively small space and retrieved within seconds. Unfortunately, none of the museums in the United States has yet installed such a system."

Background

The Division of Crustacea was most fortunate to receive through the foresight and industry of members of its forerunner, the Division of Marine Invertebrates, a remarkable file of specimen records in a 3 × 5 card format. This card file, consisting of about 125,000 entries, serves as a guide or index to the collection, a source of information on loans and holdings in general (management data), and a basic source of specimen-associated data. The existence of the record file, in a museum where specimen records, other than specimen labels and catalog books, are in general absent, is a tribute to the perseverance and foresight of such people as Mary Jane Rathbun, Waldo L. Schmitt, and Fenner A. Chace, Jr. The Marine Invertebrate catalog system has existed for approximately 70 years.

Our new system in Crustacea was designed as closely as possible to that already in existence in the Division. We wanted to show that we could continue the basic operations of documentation and cataloging of the collection and prepare the data for computer storage at the same time.

Briefly, let me summarize the pre-computer method of cataloging. A cataloger would compile the data necessary for each entry, hand enter it into a ledger catalog, hand-write the label, type two copies of a specimen data card (one copy was to be filed in the species file, the other to be filed in a geographic file), and type a neck label for the jar.

In 1965, we instituted a change in the cataloging procedure by installing a typewriter system in which a punched-paper tape could be generated during the initial typing of the data. The machine used is a CDC (SCM) Typetronic 2816 with two typewriter consoles, one featuring microelite type (with 16 characters to the inch) and one featuring standard elite type (12 characters to the inch). As the data is entered on the specimen label on the microtypewriter, the machine generates a punched paper tape which can then be used to reproduce automatically on the other typewriter as many 3×5 cards as needed for the files. The jar neck label also can be typed from the tape. The system was developed with the expectation that some day the data on the paper tapes could be converted to magnetic tape, but it was installed almost two years before we received support for the MNH project.

The cards, labels, and neck labels are printed in long perforated strips which are much easier to feed into the typewriter. Pink cards and distinctly-marked neck labels are used for types. Originally, we planned on printing up three sets of 3×5 cards, one for the species file, one to be filed in numerical order as a replacement for the permanent ledger catalog, and one for the geographic file. Henry B. Roberts, Senior Museum Specialist in the Division of Crustacea, did most of the work involved in developing the new card format from the old one.

At the time the program was started, Smith-Corona-Marchant (SCM) (now Control Data Corporation) was the only manu-

TABLE 1. Data Organization, Division of Crustacea.

Field Name	Maximum Length
Nomenclature type	15 spaces
Catalog number	8 "
Genus name	21 "
Subgenus name, if used	21 "
Species name	21 "
Subspecies name, if used	21 "
Author	50 "
Total number of specimens	5 "
Location I: Continent, country, ocean	30 "
Location II: State, province, island group	30 "
Location III: County, parish, small island	30 "
Location IV: City, lake, miscellaneous	70 "
Latitude and Longitude	48 "
Collection Gear	20 "
Depth	20 "
Collector	20 "
Collector's number	12 "
Date of collection	11 "
Identifier	33 "
Date of identification	11 "
Number and sex of specimens	45 "
Accession number	10 "
Type of entry (gift, etc.)	13 "
Publication information	45 "
Preservative	3 "
General remarks, and overflow from 180a	45 "
General remarks	45 "
General remarks	45 "
General remarks	30 "
Data cataloged	11 "

facturer of a system with a micro-elite typewriter. Since then, we have learned that SCM no longer will manufacture the Typetronic. Fortunately, perhaps, for those who require the micro-typewriter, Friden now manufactures one and can supply a system comparable to the Typetronic.

A more detailed account of the development and use of the cataloging procedure was given by Squires (1966).

USNM - DEPARTMENT OF INVERTEBRATE ZOOLOGY PARATYPE
CAT. NO. 100932 Lysiosquilla grayi Chace
Σ SPECS. 7
LOCAL. United States;Massachusetts;Cape Cod;Bass River
/
DEPTH intertidal
COLL. BY Gray, M. B. 18 Mar 1957
DET. BY Chace, F. A. Jr. -- --- ----
NO/SEX 2♂, 5♀
ACC. NO. 206768 ENTERED AS PRES. alc
REMARKS
Biological Bulletin, Woods Hole, vol. 114, no. 2, p. 141, pl. 1, figs. 1-5, 1958.
Muddy sand at low water.

SI-MNH-172-REV. 9-20-67 DATE CAT. 14 Nov 1957

USNM-INVERTEBRATE ZOOLOGY PARATYPE
100932 Lysiosquilla grayi Chace
Σ SPECS. 7
United States;Massachusetts;Cape Cod;
Bass River/

DEPTH intertidal
Gray, M. B. 18 Mar 1957
Chace, F.A.,Jr. -- --- ----

FIGURE 1. Catalog card and corresponding label used in Division of Crustacea, Smithsonian Institution.

TYPES OF DATA ENTERED

In our cataloging operation in Crustacea, the basic unit is a lot; each lot contains one or more specimens. Basic data for each lot are collected and verified by a cataloger who may receive the lot with no more data than name, number and sex of specimens, identifier and date identified, station number and vessel, and accession number. These data are expanded by the cataloger to include as much of the information shown in Table 1 as possible.

Each of these types of information must be entered on the original 3 × 5 card (Figure 1) which we retain in the division file. In Crustacea we use data assigned to 30 different fields; often some of these items are left blank. In the experiment on birds some 39 fields are used and in minerals approximately 140 fields have been identified.

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LYSIOSQUILLA   GRAYI                                                        100932
   CRUSTACEA

               WIP ACCESSION

      010A         NOMENCLATURE TYPE        PARATYPE
      020A         MUSEUM ABBREVIATION      USNM
      020A         CATALOG NUMBER           0100932
      035A         AUTHOR                   CHACE
      040A         NUMBER OF SPECIMENS      00007
      051A         MAJOR LOCALITY           UNITED STATES
      052A         SECONDARY LOCALITY       MASSACHUSETTS
      053A         SPECIFIC LOCALITY        CAPE COO/BASS RIVER
      080A         DEPTH                    00000 METERS, VARIANCE    0 METERS   GIVEN AS INTERTIOAL
      090A         COLLECTOR                GRAY, S.
      110A         OATE OF COLLECTION       18 MAR 1957
      120A         IOENTIFIER               CHACE, F. A. JR.
      130A         IOENTIFICATION OATE      -- --- ----
      140A         NUMBER AND SEX           MALE    M I   M II   M JV  FEMALE  F OV   F JV    JV   LARVAE
                                              2                          5
      150A         ACCESSION NUMBER         USNM 206768
      160A         TYPE OF ENTRY
      170A         PRESERVATIVE             ALC
      180A         PUBLICATION INFO         BIOLOGICAL BULLETIN, WOOOS HOLE, VOL. 114,
      190A         REMARKS I                NO. 2, P. 141, PL. 1, FIGS. 1-5, 1958.
      200A         REMARKS II               MUOOY SAND AT LOW WATER
      230A         OATE CATALOGUEO          14 NOV 1957
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FIGURE 2. Work-in-progress listing for same entry as shown in Figure 1.

Our limiting factor here is perhaps the number of characters we can enter on a 3 × 5 card. The system we use has the capability of storing some 4000 characters per catalog entry; we have used less than 800 in developing the data card in Crustacea.

The first two lines include the basic information pertaining to that log, catalog number, name, and total number of specimens; these are the initial data used by those who work with the files and are coincidentally the basic invoice data.

Data on the card down to and including the "Determined by" level on the card also appears on the specimen label. The remainder of the information appears in the ledger catalog and on the card, but not on the label. The label for this same lot is also shown in Figure 1. Card size was determined by the existing files and label size was determined by the size of our basic specimen vial for smaller specimens.

Upon completion of our cataloging process for a series of specimens, the tape generated by the Typetronic is forwarded to the Computer Center where the data are converted by the computer to magnetic tape. Then the data items are reshuffled by the computer to produce a Work-In-Progress Listing (WIP), a preliminary printout (Figure 2). We use this now for a second proofing of the original entry. The machine will automatically mark several kinds of errors, including erroneously marked fields, fields with no data, spelling errors in the data, data in wrong fields, etc.

Corrections may be made at any of the steps in the cataloging process. The punched paper tape can be corrected after the card and label have been proofread, and corrections of data on the WIP listings can be keypunched to update the data in the computer.

We have the potential of retrieving data items by field or by any combination of fields. Further, the data can be rearranged by fields in any format which one might require.

Note that depths are converted to meters; if a depth range is given in the original entry, the midpoint is the first depth given in the printout. In printouts, the midpoint (in meters), the range (in meters) and the original entry, as given in feet, meters, or fathoms, are all reproduced. All depth conversions are automatic.

We have left several fields vacant in the section entitled REMARKS. These can be used for habitat information, for references to field notes or color photos, and so on. These fields are unrestricted at the present time.

The basic card system in Crustacea is extremely adaptable. Although designed for marine organisms, it has been modified with little effort to include crayfishes where locality data may be centered on drainage system and where information on associated species, cross-referenced to field notes, is required. We are now adapting the format to free-living marine nematodes and to cephalopods.

I want to discuss here in a little more detail two of the types of information entered and used, Nomenclature and Geography.

Nomenclature

The system is designed so that a taxon is a focal point for entry and retrieval of data. For each group a master taxa list must be compiled and entered.

In preparing the master list for the stomatopods, I have included major synonyms. The entries for one species, *Odontodactylus brevirostris* (Miers), are shown in Figure 3.

Data on this species can be requested by using any of the synonyms or the senior synonym in the query. Few of our collections are up to date nomenclatorially for few of us have the help required to keep up with the name changes. By being able

000 0002 330	G	ODONTODACTYLUS		GENUS
000 0002 331	RG	BIGELOW, 1893		REMARKS
000 0002 340	B	ODONTODACTYLUS	BREVIROSTRIS	
000 0002 350	RB	(MIERS, 1884)		REMARKS
000 0002 355	SB	GONODACTYLUS	BREVIROSTRIS	SYNONYM
000 0002 356	RB	MIERS, 1884		REMARKS
000 0002 360	SB	GONODACTYLUS	HAVANENSIS	SYNONYM
000 0002 361	RB	BIGELOW, 1893		REMARKS
000 0002 370	SB	ODONTODACTYLUS	HANSENII	SYNONYM
000 0002 371	RB	POCOCK, 1893		REMARKS
000 0002 380	SB	ODONTODACTYLUS	LATIROSTRIS	SYNONYM
000 0002 381	RB	BORRADAILE, 1907		REMARKS
000 0002 390	SB	ODONTODACTYLUS	SOUTHWELLI	SYNONYM
000 0002 391	RB	KEMP, 1911		REMARKS
000 0002 400	SB	ODONTODACTYLUS	NIGRICAUDATUS	SYNONYM
000 0002 401	RB	CHACE, 1942		REMARKS
000 0002 410	B	ODONTODACTYLUS	CULTRIFER	
000 0002 420	RB	(WHITE, 1850)		REMARKS
000 0002 421	SB	GONODACTYLUS	CULTRIFER	SYNONYM
000 0002 422	RB	WHITE, 1850		REMARKS
000 0002 430	B	ODONTODACTYLUS	HAWAIIENSIS	
000 0002 440	RB	MANNING, 1967		REMARKS

FIGURE 3. Synonymy of *Odontodactylus brevirostris* (Miers) as stored in the computer Directory of Names.

to identify and label synonyms, entries in the data bank under any of the names can be retrieved.

A separate directory of names is maintained and, as catalog entries are added, the names are checked against the directory; entries accompanying names not in the directory are rejected as are entries under misspelled names.

Neither the user nor the cataloger need be familiar with the numericlature used by the machine; only knowledge of the nomenclature is required.

We have also developed a hierarchical classification, for we believed that data must be retrievable not only at the specific level but at any of several taxonomic levels. In Crustacea we have compiled a hierarchy down to suborder, to which we can eventually add families, genera, subgenera, and species. A portion of the crustacean hierarchy is shown in Figure 4. The numbers on the right are the numericlature; those on the left are part of a sequence of numbers required to enter the data originally and are not related to the numericlature.

Our numerical code of 26 digits was developed to allow maximum flexibility in adding to the hierarchy at any level and to maintain the specific name as the key to entry and retrieval of data. Neither the cataloger nor the scientist user needs to know the entire number sequence; it is internal in the computer.

SEPT 26, 1968 HIGHER TAXA NUMERICLATURE LISTING

GROUP PAGE-LINE	TYPE LVL	TAXA	NUMERICLATURE
0000029125	C	LEPTOSTRACA	1 032 008 000 0000 0000 000000 00
0000030130	O	NEBALIACEA	1 032 008 001 0000 0000 000000 00
0000031140	C	RHINOCARINA	1 032 009 000 0000 0000 000000 00
0000032150	C	CERATIOCARINA	1 032 010 000 0000 0000 000000 00
0000032160	SC	CERATOCARINA	1 032 010 000 0000 0000 000000 01
0000033170	C	NAHECARIDA	1 032 011 000 0000 0000 000000 00
0000034200	C	SYNCARIDA	1 032 012 000 0000 0000 000000 00
0000034205	D	ANASPIDACEA	1 032 012 001 0000 0000 000000 00
0000034206	D	BATHYNELLACEA	1 032 012 002 0000 0000 000000 00
0000035209	C	PERACARIDA	1 032 013 000 0000 0000 000000 00
0000036220	D	THERMOSBAENACEA	1 032 013 001 0000 0000 000000 00
0000037230	D	SPELAEOGRIPHACEA	1 032 013 002 0000 0000 000000 00
0000037235	O	MYSIDACEA	1 032 013 003 0000 0000 000000 00
0000039250	O	CUMACEA	1 032 013 004 0000 0000 000000 00
0000039260	SO	SYMPODA	1 032 013 004 0000 0000 000000 01
0000040270	O	TANAIDACEA	1 032 013 005 0000 0000 000000 00
0000040280	SO	CHELIFERA	1 032 013 005 0000 0000 000000 01
0000040290	SO	ANISOPODA	1 032 013 005 0000 0000 000000 02
0000041300	O	ISOPODA	1 032 013 006 0000 0000 000000 00
0000042310	O	AMPHIPODA	1 032 013 007 0000 0000 000000 00
0000042320	SO	LAEMODIPODA	1 032 013 007 0000 0000 000000 01
0000042325	C	EUCARIDA	1 032 014 000 0000 0000 000000 00
0000043330	O	EUPHAUSIACEA	1 032 014 001 0000 0000 000000 00
0000044340	O	PYGOCEPHALOMORPHA	1 032 014 002 0000 0000 000000 00
0000045350	O	DECAPODA	1 032 014 003 0000 0000 000000 00
0000046358	C	HOPLOCARIDA	1 032 015 000 0000 0000 000000 00

FIGURE 4. A portion of the crustacean classification used in the MNH project.

The hierarchy, to order, was arbitrarily selected and entered into the computer. Aspects of classification can be updated at any time and categories below order can be entered at any time. The classification of invertebrates proposed by Blackwelder (1963) was used as the basis for the hierarchy.

Assume that we have completed sections in Crustacea and now plan to enter any other invertebrate group. The hierarchy will accommodate 999 families under any order, and, further, up to 9 additional families can be entered at some future time between any 2 of the original entries, [without changing the numericlature assigned to the original families entered]. Similarly, up to 99 genera can be assigned to each family and 9 genera can be added between any of two of the original genera. The number of species that can be entered originally in each genus is 9999, with room to add 99 between any 2 of the original entries.

Data can be entered by genus or higher category only and also be retrieved by those categories. Data associated with such designations as variety, forma, species near *xus*, new species, etc., can also be entered and retrieved. The system is flexible enough to handle subgenera and subspecies as well.

Geography

Emerson and Ross (1965) and Levi (1966) have commented on the importance of locality data in collections of invertebrates, and other authors have cited one or more methods of recording geographic data, including distance and direction from a known point to a locality (10 mi. N., 4 mi. E) (Riemer, 1954; Hutchison, 1964), use of township, section, and range (Axtell, 1965), legal description (Wheeler, 1965), and so on. In studies on marine animals, latitude and longitude (Axtell, 1965; Steward, 1965) or Marsden Square are commonly used. All of these methods have specific applications; none are used exclusively by all taxonomists.

For these reasons we have had to develop our own geographical code, called the Global Reference Code, designed by Reginald Creighton, Anthony Piacesci and Dick King of the Smithsonian Information Systems Center when it became apparent that existing methods of storing retrieving geographic data had too many limitations. Creighton and his colleagues are preparing a paper on development of the Code.

The Global Reference Code is a hierarchical system in that several levels, from the general, such as Pacific Ocean, to specific, such as Manila Bay are used, with room for four levels of complexity. Locality data may be entered by latitude and longitude or by name.

Latitude and longitude are assigned to specific localities by hand, and a separate geographic data bank is maintained by the computer.

The smallest area defined by the GRC is a two-minute square. All data referring to localities within each two-minute square can be retrieved and printed out as originally entered.

The following example will demonstrate the flexibility of the system. Soldier Key is a small island on the eastern edge of southern Biscayne Bay, Dade County, Miami, Florida. It may be identified, in different collections within the museum, as (a) Soldier Key, (b) a small isolated key 10 miles south of Key Biscayne, Miami, (c) a key north of Elliot Key, Biscayne Bay, or (d) it may have been identified originally by its coordinates or by compass bearing and range from a point. If information on species found at Soldier Key is required, the computer will select and print out all of the data given above, as originally entered.

This has numerous benefits, for we can retrieve data by latitude and longitude, ocean, county, state, drainage system, Marsden Square, or by any of existing methods of recording locality data.

Eventually, as the geographic data bank develops, routines can be developed so that it can be searched for specific geographic data and reenter these into the catalog record automatically.

Results

Initially there was a serious lag between development of computer programs for data storage and manipulation, as well as development of formats for geography, so that by the time the programs were ready a large series of records had accumulated awaiting entry into the system. We then learned that all of our entries accumulated in this period had to be redone for a variety of reasons, primarily because the fields for each entry had not been identified correctly. The beginning and end of each field must be flagged or marked by the typewriter operator and the flag, an asterisk or an exclamation point, must appear on the tape, or, as far as the computer is concerned, the fields cannot be identified and the record is invalid.

Although we believed we had designed the system so that we could eventually phase out the ledger catalog, i.e., it would be replaced by a card file in numerical order, we quickly learned that a ledger or equivalent, in the form of a work sheet, was required in order to prepare and arrange the data. We still use the ledger and we have dropped, at least temporarily, the numerical card file.

Now that the geographic data bank and the Global Reference Code has been developed and is functional, we should be able to replace the geographic card in our cataloging operation.

I have noted above that we learned that verification and assembly of data by a cataloger, in preparation for the actual typing operation, required the use of a ledger catalog or data entry sheet of some sort. From an operational point of view it was much simpler for the trained cataloger, a data specialist, to work with the specimens in an area not necessarily adjacent to the typewriter. Alcoholic collections are too messy for the basic work to be done at or near the typewriter. Initially, we used the cataloger not only as a data specialist but also as a typewriter operator. We have learned from our first year of operations that the cataloger can be reserved for the data-verification aspects of the operation, and that the data can be entered by a clerk-typist. Further, a clerk-typist can enter data far faster than any one cataloger can prepare it.

As we recataloged the stomatopods, data for the types was entered along with data for all of the other specimens in the collection. In working with the preliminary printout, the Work-In-Progress listing, of the data from the types, it became apparent that it would be relatively simple to reformat the data and generate a type-catalog by the computer.

A program has been developed and the printout has been requested. We expect to obtain in one printout an alphabetized list of the types, as cataloged under their original names, along with a list of the current names for those that have changed since the original description.

Another finding is that our data input is not completely satisfactory, for we need the capability of including more habitat data. We had reserved space under "Remarks" for habitat data, reference to field records, color notes, and so on. In the case of many of our specimens, there is relatively little information available other than locality, date, and collector. Now the number of records with habitat data is so slight that our inquiries can be worded so that only records with information in the "Remarks" section are printed. We will be working on this.

On the cards themselves, we have reserved space at the bottom to edge-punch the cards with the basic data for invoices; catalog number, name, and total number of specimens. If the cards were punched as they were processed, we could eventually be in a position to generate invoices of loans from our cataloged collection by stacking cards, in the order desired, in the Typetronic reader and let the machine automatically type out the basic data. Unfortunately, edge punching obliterates any entries in the "Remarks" section so we have not implemented this as yet.

Possible Experimental Programs

During the second part of the project we plan to begin manipulation of the data base built up during the first 18 months of operation. Interrogations designed to test the capabilities of the system and to provide information as retrieval costs might include the following:

(1) List and count all species in genus represented in collection.

(2) Determine number of species in given collection and state source.

(3) List all materials identified from accession Z.

(4) What species of Family X occur together in depth range X–Y in the northwestern Atlantic. Plot distribution pattern of each species.

(5) What species in genus X are not represented in the collections.

(6) List by accession number material of family Y from the eastern Pacific not yet identified to species.

(7) List species occurring at island X.

(8) List species collected by ALBATROSS at Sta. X.

(9) List type-species of family X or order Y not represented by materials in collection.

In addition to working out various queries and testing the system, I would like to work on several items. I have already noted that in some cases adequate data, available from field notes, etc., cannot be entered on the 3 × 5 specimen card. I would like to develop a station data Directory, similar to our geographic Directory, in which all data pertaining to a particular station or collection could be entered and also be available for combination with the basic catalog data by the computer.

For example, Dr. Waldo L. Schmitt kept extensive field notes which relate directly to many specimens now in the crustacean collection. If we could enter all of this by station number and have the computer add this data to each printout record, we could greatly increase the amount of information available on each specimen. For the purposes of management of our collection, this information is not neccessarily needed in our species file. Its value for research purposes is obvious.

Similarly, data from Smithsonian expeditions and other expeditions as well might be stored and tied to the specimen record by the station number.

We also plan to develop a basic catalog card for parasites and commensals from our crustacean holdings which will emphasize host and ecological data.

During the coming year we plan to investigate various applications of the computer and the computer-based specimen data bank to our routine operations. The possibilities are unlimited. We should be able to generate invoices giving complete specimen data, lists of holdings for visitors, lists of holdings for exchange purposes, as well as a machine-generated catalog in tabular form which could be bound and retained as a permanent record. Entry of present unidentified material (identified to family or genus level, but not species level), would enhance our abilities to make our collections and these data available to visitors.

Development of off-campus storage facilities for inactive collections, in my opinion, is dependent on development of banks of data associated with those collections; removal of collections to off-campus facilities without documentation of the material would be tantamount to destruction of the material.

I would also like to see the museum develop methods for computer storage of records from the literature as well as data associated with specimens in our collection.

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